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INDUSTRIAL DERMATOSIS AMONG PRINTERS.

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A dermatosis, called "ink poisoning" by printers, which affects those parts of the arms and hands that are subject to constant contact with colored inks, is known to have prevailed for many years among printers in the large printing and engraving plants of this country; and the attention of dermatologists has been attracted by discussions in foreign medical periodicals of cases of a similar dermatosis.

The weight of blame for this dermatosis is attributed by foreign writers to the many substitutes for and adulterants of the pure oil of turpentine.

Oestreicher,[1] of Berlin, who has had occasion to treat a great many cases of skin diseases among printers, says that the workmen reported unanimously that the disease had appeared only since the introduction of a substitute for the oil of turpentine. In this particular instance the oil was replaced by a heavy benzine, benzol, and fats. He further remarks: "There remained only the problem why all the workmen who had to do with the turpentine substitute were not equally affected with the disease. The solution is found in the fact, familiar to all observers, that the skin of different individuals responds very differently to outer influences."

Zellner and Wolff[1] made an investigation into the same condition, because it was found that for many years skin diseases had been appearing more and more frequently among members of the Printer's Sick Fund. Their investigation, and information collected from questionnaires, led them to the following conclusions:

"1. It appears that pure oil of turpentine seldom causes disease. With the firms which used pure oil of turpentine as washing material, cases of sickness occurred only sporadically or not at all.

"2. Very different was the situation with those firms which used impure oil of turpentine or which used substitutes. Many of the substitutes for oil of turpentine were exclusively benzines. Since all the substitutes which were submitted to us turned out to be benzines, we have to advise against the use of these substitutes, and of course, against benzine also."

Gebert[2] in discussing similar cases, was not sure whether the impure hydrocarbons have something to do with the dermatosis, or whether impurities proceeding from the ink are the final cause of the affection. In reply Blaschko [2] said:

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[1] Magazine of Hygiene and Infectious Diseases. Fluegge and Gaffky, Leipsic, 1913, vol. 75, pp. 69-80.

"Several years ago I presented in this very association a number of workmen from a great printing establishment where an epidemic deterioration, so to speak, had suddenly appeared. This probably came from an irritation due to grease or to materials for cleaning. Among printers the source of irritation is hydrocarbon oil, but often turpentine and also printer's ink. This last consists essentially of fine coal dust, so that the conditions are similar to those which obtain among chimney sweeps. If printers escape cancerous formations, it is because they come in contact with these substances only with thickened epidermis of the hand, and because the workmen always wash immediately after the work."

Inquiries made of the larger printing and engraving firms of this country disclose the fact that although neither oil of turpentine nor a substitute is used, still the arms and hands of the pressmen develop lesions similar to those described by these writers.

The skin lesions vary from slight erythema to ulcerations, and are located on all regions of the forearms and hands, occasionally extending above the elbow. Some of the lesions present a dry and scaly appearance, while others are moist and vesicular. Some have a tendency to coalesce and spread, others are discrete. A history of erythema followed by vesicular eruption, with itching or burning or both, is given by most sufferers, only a few giving a negative history in this respect.

In response to requests for advice on methods of prevention and treatment of such cases, a study to determine the possible relationship of the dermatosis to the use of inks was recently undertaken by the United States Public Health Service.

Scope of Investigation.

While hearty cooperation in the investigation was offered by many plants where there were cases of dermatoses, on account of the similarity of the plant processes the study was confined to one plant, and embraces the following subdivisions:

1. Methods of plate printing.
2. Process in which the dermatosis occurs.
3. Materials used in processes.
4. Methods employed in removing the inks.
5. Physical examination of workers affected.
6. Physical examination of controls.
7. Discussion of medical findings.
8. Analyses of inks, oils, and soaps.

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[2] From the Proceedings of the Berlin Dermatological Society, June 10, 1913, Magazine of Dermatology, Berlin, 1913, p. 813.

9. Experimental work on volunteers.
10. Conclusions.
11. Preventive measures recommended.
12. Treatment.

1. METHODS OF PLATE PRINTING.

There are two types of printing presses in the plant where the study was made; one is operated by hand and the other is electrically driven. Two persons are employed at each hand press; one printer, male, and one printer's assistant, female, working on an 8-hour shift. The frame of the press is of cast iron, and it supports two steel rolls, between which a traveling iron platen operates. To this platen is attached the case-hardened engraving plate, which is inked and polished by hand before the press is started. A star wheel, operated by the printer, is connected to the lower roll in such a way that, after the plate has been inked and polished, and a predampened sheet of paper has been placed over it, the iron platen together with the paper and plate is carried underneath the upper roll, which forces the paper down sufficiently hard upon the inked plate to print the engraving. The upper or pressure roll is covered with two wool felt blankets. These, in turn, are protected from dampness by a rubber blanket, made by surfacing a coating of rubber on a cotton drill backing.

Each power press is operated by one printer, male, and two printer's assistants, female. On the power press, the bedplate, similar to the platen in use on the hand press, makes a complete circuit of the press. The engraved plate is inked mechanically, polished by hand, and carried across in front of the padded pressure roll, where the first printer's assistant places one sheet of dampened paper over the plate. It then passes under the pressure roll, where the impression is made. The second printer's assistant takes the sheet off the plate, which is reinked and carried back to the front of the press, ready for the next sheet.

Since the speed of the power presses is controlled by a motor, the printer must adjust himself to his machine, and the speed is usually great enough to require a fairly active operator. The speed of the hand press, on the contrary, depends upon the printer entirely, for the machine operates only as he sets it in motion.

2. THE PROCESS IN WHICH THE DERMATOSIS OCCURS.

A study of the processes and practices reveals the intimate and constant contact between the printer and the materials used. Over the face of the plate, which rests on a warm table heated by electricity, the pressman passes an inked roller, leaving a thick film of ink on the plate. He wears short sleeves, and soon his hands and arms, particularly the ulnar surfaces which rub against the body, become covered with the ink to the elbow. The excess of ink on the plate is removed by a stiff starched cloth, and then the operator passes his right hand over the plate further to remove the ink. This movement is followed by passing the left hand (which has been previously passed over a cake of whiting and rubbed against a pad hanging at the side of the workman, to remove the excess of whiting) over the surface of the plate, to give it a final polish. This act removes the last traces of ink from the face of the plate, leaving only the engraved lines filled with the ink. The ink thus accumulates on the hands and arms of the workman, remains throughout the working period, and is removed only at the luncheon period and at the end of the shift. The printer's assistant, a woman, who places the paper on the plate and removes it after the impression is made, handles the paper only by the unprinted edges and comes very little into contact with the ink.

However, the tips of her fingers frequently become soiled; and since it is necessary to prevent soiling the paper, she often resorts to the harmful method of keeping within reach a cloth saturated with benzol, in order to remove the ink from her fingers effectively.

The power press does not require the operator to apply the ink or to remove the excess by hand; but in removing the last excess of ink and polishing the plate he soon accumulates the ink on his hands and arms, as the hand pressman does. His two assistants, one of whom places the paper on the plate, and the other, who removes the printed sheet, do not come into closer contact with the ink than do the hand-press assistants.

Only a small proportion of the ink, estimated at about 10 per cent, is used in the actual printing. The remainder is lost by the methods employed in inking and polishing the plate.

The plates are cleaned with benzol at noon and again at the end of shifts by the printer or his assistant. Gloves are not worn during the cleaning process. Kerosene is used for cleaning the machinery.

3. MATERIALS USED IN PROCESSES.

A variety of colored inks is used, and printers are subject to contact with all colors used, according to the work assigned them.

The starched cloth and whiting (calcium carbonate) mentioned in the description of the process, while they do not influence the character of the printing, are constantly employed, and may be considered as materials used in the process. Likewise, the benzol and kerosene are in daily use. A discussion of the analyses of the inks and of oils and of soaps used in removing the inks, is presented in a later section of this report.

4. METHODS EMPLOYED IN REMOVING INKS.

The removal of the ink from the hands and forearms at the end of the work period involves almost brutal treatment of the skin, the severity of the treatment varying according to the thoroughness and the special methods employed by the individual. Most workers first wash their hands and arms in a mineral oil supplied by the plant and kept in troughs in the wash rooms for cleansing purposes. Frequently the hands and arms are immersed in this oil, but in some cases the oil is applied by means of a cloth, which is often used in common. After as much of the ink as possible has been removed by the oil, the worker continues the cleansing process with soap and hot water. Frequently pumice soap and fine sand mixed with soap are used. A stiff brush and salts of tartar (potassium carbonate) are also used by some to assist in the ink-removing process. Few of the printers use emollients after washing, and so the unprotected skin is exposed to the atmosphere.

5. PHYSICAL EXAMINATION OF WORKERS AFFECTED.

In order to determine, if possible, why certain individuals acquired the dermatosis in a rather severe form after a short period of exposure, while others, working under identical conditions, either never developed the skin lesions or developed them only to a very mild degree after years of exposure, and on account of the many suppositions advanced by the men as to the cause of this dermatosis, it was decided to go thoroughly into the history of those affected, and to give each a complete physical examination. In all, 35 affected cases were examined.

6. PHYSICAL EXAMINATIONS OF CONTROLS.

At the same time, similar examinations were made of 18 men not affected with the dermatosis, but who worked, in many instances, on the same presses and under the same conditions as those affected.

7. DISCUSSION OF MEDICAL FINDINGS.

The exposure theories held by the men or advanced by other observers were given due consideration in the analysis of the findings. Most men adhere to the theory that either the inks themselves or certain ingredients contained in them act as chemical irritants of the skin. A few were of the opinion that the dermatosis is of an infectious nature; others that the materials used in removing the inks are the offending cause; and still others attributed the affection to carelessness in personal hygiene, individual susceptibility, or impaired physical condition.

Very marked differences of opinion as to the particular ink which causes the trouble were expressed by those examined. Green ink seemed to be most frequently accused; however, some of the men examined had developed lesions while working in every color, including black, so that apparently no particular ink is solely responsible for the condition. While not all cases examined presented lesions which could be attributed to the inks, each was prone, nevertheless, to blame the inks for his condition. There were no constitutional symptoms accompanying these skin lesions; neither did questioning as to habits and past history elicit information which threw any light on the causation of the condition. The workers examined were well distributed according to age, weight, and height. All were Americans.

The histories of these men failed to disclose a similar condition in any member of their families or in any individual worker himself prior to his employment involving the use of inks. This weakens any theory of infection which might be advanced. The physique and health of the individual apparently have no influence in the acquirement of the affection; some men with severe cases were otherwise in excellent physical condition, whereas some of the controls were physically below par. Nor was personal cleanliness a factor as a causative agent. One significant fact was very prominent: all persons suffering with dermatosis were found to have dry skin—that is, skin either partially or wholly devoid of natural oiliness; whereas those persons without eruptions had oily skin. This dryness of the skin is the only differentiating factor found to exist with any degree of constancy among the men so affected.

8. ANALYSES OF INKS, OILS, AND SOAPS.

A careful analysis has been made of all substances used by the men, on the hypothesis that some ingredient present is the source of the irritant action on the skin.

The Bureau of Standards, United States Department of Commerce, made most of these analyses. Assistant Chemist Harry Houghton, of the Office of Industrial Hygiene and Sanitation, United States Public Health Service, made certain additional tests to exclude specific adulterants suspected.

Linseed oil is used as the vehicle of the inks, the black ink containing the highest percentage of it and the brown the lowest. Lead chromates were found in all but the black ink. Prussian blue was found in the green and the black. Excess of lead sulphate, and also of calcium carbonate and barium sulphate, was found in all the inks with the exception of the black. Bone black is used in the black ink. All the inks were found to be free from arsenic and mercury. It seemed logical to blame the chromates for the trouble, but to do so would not account for the action of the black ink, which is free from chromates. The thought occurred that perchance a chemical change may take place when the inks come into contact with the moisture of the skin. Pursuing this theory, the Bureau of Standards reported that the mixture of pigments in the green ink yields soluble calcium ferricyanide when leached with water.

The fact that the inks retard healing after abrasion of the skin indicates the presence in them of ingredients, perhaps of chromates, which aggravate an otherwise simple dermatosis. We have reason to believe that the driers in the inks have a tendency to extract the natural oiliness of the skin.

While a number of the workers suffering with the dermatosis said that they did not use benzol, and that their assistants cleaned the plates, others admitted that they themselves cleaned the plates with benzol. The injurious effects of benzol are well known, and it is possible that some cases of the dermatosis had their origin from its use. When it is necessary to use it for cleaning purposes the hands should be protected by gloves.

The mineral oil supplied by the plant in which the study was made was examined both chemically and bacteriologically. The chemical examination was made by the Bureau of Standards, and the bacteriological examination by the Hygienic Laboratory, United States Public Health Service. The chemical examination consisted in testing the oils for the following constituents: formaldehyde, turpentine, benzol, coal oil, phenol, analin oil, lye, wood alcohol, and gasoline. All these were absent. Samples of oil were taken from each trough used by the printers and were sent to the laboratory for bacteriological examination and culture. The results show that the oil in these troughs does not act as a culture medium, but some organisms were found which are capable of causing folliculitis and kindred conditions.

Several of the workers are opposed to the use of oil in troughs, and prefer to use instead fresh oil on clean cloths. The investigator believes that some satisfactory method could be worked out whereby this cleaning oil would not be used in common and yet would be used economically.

Two samples of soap used in the plant were examined for free alkali by the Hygienic Laboratory, but were found to contain no alkali.

9. EXPERIMENTAL WORK ON VOLUNTEERS.

It had been intended to carry on a series of experiments on laboratory animals, such as guinea pigs, rabbits, mice, dogs, and cats, to determine the effects of the inks when in prolonged contact with the skin; but reports on previous experimentation of this kind and the necessity of shaving parts of the animals, a process which would in itself produce an abnormal condition, convinced the examiners that the results would be very unreliable and perhaps misleading; therefore volunteers from the Office of Industrial Hygiene and Sanitation were called for, and at the same time the printers affected with the dermatosis were asked to report at regular intervals for advice and treatment.

Eleven subjects were used for the experiments. The "trial and error" method was employed. The various colored inks were experimented with. Ink was applied to the posterior surface of the forearm, about midway between the wrist and elbow, upon an area of approximately 9 square inches. Instructions were given not to remove the ink. The application was repeated every day for a period of a week in some cases, and of four weeks in others. Five of the volunteers had oily skin, and six had dry skin. At the same time two printers afflicted with the dermatosis were instructed not to remove the ink from a similar area on the forearm. In no instance was there any sign of irritation.

The experiments were repeated with the oil supplied by the plant, and likewise no irritation was experienced. Two men suffering with the dermatosis gave a history of not using the oil for over a year, believing it to be the cause of their trouble, but their condition was in no way improved.

In the next series of experiments instructions were given to remove the ink each evening with soap and water and with the aid of a brush. One subject who had a very dry skin reported the next morning, complaining that the area from which the ink was removed was raw, tender, and painful. The remaining five with dry skins and one with an oily skin reported that their arms felt slightly sore, but no irritation was discernible. The others experienced nothing unusual. It was the opinion that the black ink was most easily removed, and that removal of brown and green required more effort. By repeating these experiments it was found that all those with dry skin complained more and sooner of the irritant action than did those with oily skin. In one case a lesion developed similar to those found among the printers. One man discovered that he could remove the ink as effectively with a rough wash cloth, soap, and water as with a brush, and with less pain. On account of the ferricyanide yielded by the green ink, this powder was used alone and also in combination with linseed oil and water, with the result that no irritation nor skin lesions were produced.

In another series of experiments the skin was first irritated, and in some cases the surface was abraded, as in the procedure followed in vaccinating, and the ink was then applied. A similar surface was abraded at the same time on each person, and the oil was applied.

The abraded surfaces where the oil was applied soon healed; those where the ink was applied required three to five days longer for healing. The green and brown inks delayed healing longest, and the black for the shortest time. It was found that when the skin was thoroughly dried and cleaned with alcohol, the ink was removed with greater difficulty. Again, after applying some of the linseed oil used in the inks and following this with an application of the ink, the latter was removed with less difficulty. In order to eliminate the use of sand, pumice soap, and hand brushes, as aids to the removal of the inks, sawdust mixed with liquid green soap was used. This was found more effective than any of the other agents. Again, when lanolin was applied to the skin before the application of the ink, the latter was very easily removed by washing with sawdust, green soap, and warm water.

The men suffering with the dermatosis who continued to report for treatment were furnished with lanolin and the mixture of sawdust and green soap, with instructions to apply the lanolin before entering the pressrooms, to wash at the lunch period, using the sawdust mixture to remove the ink, again to apply the lanolin before returning to the press, and to wash as before at the end of their shift.

Those men suffering with severe skin lesions were given the following compound in solid block form:

Zinc ore (calamine and a silicate of zinc), pulverized and passed through a 100-mesh sieve	3 parts.
Gelatine	4 parts.
Glycerine	5 parts.
Water	6½ parts.

They were also given a copy of the following directions for using the calamine paint:

"(1) Melt the solid block in the inner pan of a double saucepan, the outer pan of which is filled with water and heated on a fire or gas stove.

"(2) When completely melted, stir with a stiff-bristled, common paint brush. If the paint is too stiff, as it frequently is, add a little hot water until the proper consistency is obtained. This should be about that of a thick sauce or sticking paste. If too much water should be added in doing this, the excess can soon be eliminated by prolonged heating or by adding more of the solid block.

"(3) Paint over the part afflicted with a single thin layer of paint, and before it has set tap lightly all over with a piece of absorbent wool, so as to form a kind of feltwork with the paint.

"(4) Allow it to set completely before putting any clothes over it.

"(5) Leave it on until it begins to come loose; then peel off and apply more in the same manner.

"N. B.—If the patient complains of its being too hot when applied, it is probably because too much is taken up in the brush at a time; this is easily obviated by emptying the brush on the side of the pan before applying the paint."

Improvement in the lesions was soon noticed; and in some cases the results were surprising. One case in particular is significant—that of a young man who had just returned to work after over a month's absence, during which time he was receiving treatment which did not improve his condition. When first seen, on August 30, 1920, this man had well-developed lesions covering the dorsum of both hands and arms, and the interdigital spaces, together with a concurrent, inflamed, and swollen condition of the fingers and hands. In order to assist the treatment, two weeks' rest was recommended; but the patient refused to take it, saying that he had already lost too much time, and promising to avail himself of the rest on or about October 1. The treatment, as outlined above, was instituted, and without losing an hour's time, or changing inks, this man responded to treatment, and when last seen, on October 5, the lesions were hardly discernible. This is by no means an isolated case. Those who consistently followed the above instructions were soon repaid by a noticeable improvement of their condition. Others who failed to notice any magic change in their skin lesions on one or two applications discontinued the treatment.

10. CONCLUSIONS.

1. Our experiments in using the inks upon the unbroken skin failed to cause a dermatosis or even an irritation. The inks delayed healing to a varying degree when applied after abrasion of the skin; the brown and green delayed healing longest, and the black for the shortest time.

2. All inks, irrespective of color, when removed by the methods in vogue at the plant at the time of this study caused an irritation—and in one case a dermatitis—among those with dry skin.

3. The degree of dermatosis apparently depends upon the dryness of the skin, the amount of linseed oil in the ink, and the method of removing the ink. It is believed that the reason why some men develop the condition in a short time and others after a long period of time lies in the degree of natural oiliness in the skin of the individual. Again, with those who use the black ink, which has the largest proportion of oil of all the inks, the trouble is further delayed. It may be that the drier in the inks has a tendency to extract the oil from the skin of some individuals. Those who do not wear gloves when cleaning the plates with benzol may more readily acquire a dryness of the skin. The dry skin might be compared with a blotter, which very readily absorbs the oil in the inks and the pigments

which are carried with the oil. These pigments, in turn, are obviously removed from a dry skin with more difficulty than they are from a skin which is already oily and which absorbs little or no additional oil from the inks. More scrubbing is required in the case of the dry skin, and a dermatitis soon begins. The inks retard healing, and from repeating the process daily, a severe case of eczema may develop.

4. The oil supplied by the plant in no way contributes to nor influences the dermatosis.

5. The prophylactic measures recommended, if used constantly and under supervision, will prevent the dermatosis.

6. The skin lesions respond readily to the treatment with calamine paint.

11. PREVENTIVE MEASURES RECOMMENDED.

While it is desirable in various processes to remove substances which are detrimental to health, it is unfortunately not always possible to remove them, any more than it is possible to remove the electricity from a charged wire, in order that the worker handling it need not wear rubber gloves; therefore it becomes the duty of the worker to equip himself properly for his work, and it is advantageous to the management to see that the worker is so equipped.

A supply of lanolin or a mixture of lanolin and olive oil in equal parts should be placed in suitable receptacles in the wash room where the printers and those who handle the inks change their street clothes for work clothes. Before entering the press rooms, each worker should be required to rub lanolin well into the pores of the hands and arms. If the skin feels too greasy after this application, the excess may be wiped off with a clean cloth. At the luncheon period these workers should be supplied with a mixture of sawdust and liquid soap (the sawdust should be moistened with the soap), which, together with warm water, will readily remove the ink without injury to the skin. It is optional with the men to precede the sawdust and soap with the oil supplied by the plant. Before entering the press rooms, the first process described above should be repeated; and at the end of the shift, the second, or cleansing, process should be repeated. The foremen in these rooms should be responsible for their helpers' carrying out the preventive measures.

12. TREATMENT.

As soon as the foreman notices an incipient eruption on the hands or arms of any worker in his department, he should insist that the worker report to the medical officer, who will furnish him with the compound referred to above, and instructions for its use.